

APPENDIX B: GENERAL INFORMATION ABOUT DPFs FOR STATIONARY EMERGENCY STANDBY DIESEL ENGINES

Diesel Particulate Filters (DPFs) for Stationary Emergency Standby Engines

What is a DPF?

A DPF is a diesel particulate matter control technology that consists of a porous substrate or a wall-flow type filter situated in the exhaust stream of a diesel engine. As exhaust gases pass through the system, particulate emissions (i.e., diesel soot, comprised mostly of carbon) are collected and stored within the filter substrate.

What types of DPFs are available?

Since a filter's holding capacity is limited, the filter system must have the ability to remove accumulated particulate matter. This removal, commonly referred to as regeneration, must occur periodically before the filter element becomes plugged, leading to DPF failure and/or engine damage. There are two types of DPF systems named for the method in which they regenerate the filter element.

Passive DPFs

Passive regeneration systems involve burning off, or oxidizing accumulated particulate matter on the filter by utilizing engine exhaust temperatures in combination with a catalyst. Catalysts may be applied as a coating on the filter substrate, which helps lower the ignition temperatures required for oxidation of the accumulated particulate matter. During engine operation, particulate matter (PM) is collected on the filter substrate, and as the engine exhaust temperature increases, the accumulated material is oxidized by the exhaust gas. Catalysts can also be situated upstream with either a bare or catalytically coated filter to facilitate oxidation of nitric oxide (NO) to nitrogen dioxide (NO₂). The NO₂ oxidizes the collected particulate in the filter and substantially reduces the temperature required to regenerate the filter.

Active DPFs

Active regeneration systems use supplied heat to continuously regenerate the filter, and are not dependent on engine exhaust temperatures for filter regeneration. These systems may require more sophisticated hardware, electronic controls, and monitoring systems to modulate exhaust gas flow, control filter regeneration, and monitor exhaust backpressure and temperature.

What should be considered when selecting a DPF for an engine?

DPFs should be installed on the specific or similar engine or engine models listed on its CARB verification, and using recommendations from the manufacturer. Below are several parameters that should be noted.

Engine Type

Most DPF manufacturers require that engines utilize a four-stroke combustion cycle that does not employ exhaust gas recirculation.

Engine Emission Rate

DPFs are typically intended for use on diesel emergency standby engines meeting an emission rate no more than 0.2 g/bhp-hr. Rule 1470 requires an emission rate of no greater than 0.15 g/bhp-hr for new emergency standby engines. Additionally, some passive DPF manufacturers require a specific NO_x to PM ratio.

Engine Exhaust Temperature

Engines should be capable of producing the required exhaust temperature necessary to regenerate the DPF for passive systems. Engine exhaust temperatures are related to the load put on the engine.

Engine Sizing

Engines should be sized to match the demand of its intended use at the facility to ensure that typical engine loads are adequate to produce necessary exhaust temperatures specified by the manufacturer to regenerate the DPF. Engines that are oversized may require the use of a load bank or periodically be run to provide building power in order to reach required loads for regeneration.

Engine Fuel Type

DPF manufacturers typically require that engines use California diesel fuel with less than or equal to 15 ppm sulfur.

What do I need to know before installing my DPF?

It is important that the end user verifies the compatibility of the DPF and the engine that it is to be installed on. It is recommended that DPFs be installed according to Pre-Installation Compatibility Assessment guidelines set forth by the California Air Resources Board (CARB)'s Verification Procedures and manufacturer's recommendations in their installation, operation, and maintenance manuals. During the air quality permitting process, SCAQMD staff will evaluate key parameters based on the DPF manufacturers' specifications and CARB Executive Orders, in order to verify the compatibility of an engine/DPF system. Key parameters to assess compatibility may include, but are not limited to: PM emission rate, engine type/description, engine exhaust temperature profile, fuel type, NO_x to PM ratio (if applicable), and other requirements specified by the DPF manufacturer. Additionally, key operating parameters, such as manufacturer's recommended regeneration, cleaning, and maintenance intervals will be included in SCAQMD permit conditions to help ensure the continued performance and reliability of the DPF.

What requirements must be followed for the operation and maintenance of my DPF?

Many stationary emergency standby engines are typically operated, or exercised, for maintenance and testing on a weekly, bi-weekly, or monthly basis at low or no engine load. Successful implementation of DPFs on stationary emergency standby engines requires increased diligence on the part of engine owners/operators and a departure from "typical" engine operating practices. At a minimum, DPFs should be operated and maintained following conditions found on its executive order issued from CARB and recommendations from the manufacturer. It is also critical that the exhaust backpressure is monitored to ensure that the filter does not get clogged.

Engine manufacturers set limits on engine exhaust backpressures so end users will have to install a backpressure monitoring and operator notification system with every DPF. Operators should be properly trained to recognize and respond to high backpressure alert signals. These monitoring systems should also be inspected periodically for proper operation.

Why do I have to regenerate and clean my DPF?

As a DPF collects soot, the passage of exhaust gas through the filter substrate is progressively blocked and the engine exhaust backpressure increases. Excess exhaust backpressure can increase exhaust temperatures, increase CO and PM emissions, and load the filter at a faster rate. The filter system must have the ability to remove accumulated particulate matter before the filter element becomes plugged, leading to DPF failure and/or engine damage. In order to prevent excess accumulation of particulates in the filter element and elevated exhaust backpressure conditions, DPFs must be periodically cleaned utilizing two methods, regeneration and cleaning (de-ashing).

Regeneration

Actively regenerating DPF systems perform filter regeneration by utilizing supplemental heat sources to combust trapped particulate matter by increasing exhaust gas temperatures or by directly heating the filter element. Operators of passive DPF systems must manually regenerate the filter to burn off the accumulated diesel soot. Manufacturers will indicate the duration that the engine can operate between regeneration events. For emergency standby engines, this is often identified in terms of the number of cold starts and 30 minute idle sessions that the engine can perform before the DPF requires regeneration. Since typical operation of emergency standby engines includes periodic maintenance and testing operations with low or no engine load, it is essential that the engine owner/operator verify that filter regeneration is occurring within manufacturer specified guidelines. Changes to testing frequencies (i.e., weekly to monthly) can extend the time needed before filter regeneration as this will decrease the numbers of cold starts and engine use at low loads over the same given time period.

Cleaning/De-Ashing

Regeneration only removes the carbon portion of the diesel soot produced from the engine. The portion of the soot that is not combustible is referred to as ash and comes from additives in the fuel, oil, or combustion air. The ash must be removed from the DPF. The frequency of cleaning a DPF depends on several factors including how well maintained the engine and filter are, the PM emission rate, and engine use. In general, a DPF on a well maintained engine that operates 50 hours per year will need to be cleaned once every 20 years. Filter cleaning typically involves manual removal of the DPF filter element for off-site cleaning by a service provider or the DPF manufacturer. Off-site filter cleaning is typically performed utilizing enclosed cleaning stations which use pulses of compressed air, mechanical vibration, thermal regeneration, or a combination of the aforementioned methods, to remove accumulated ash and other materials from the filter substrate. DPF manufacturers may also make available to the end user specific cleaning tools, instructions, or a list of service providers to facilitate ash cleaning.

What can I do if typical operation, testing, and maintenance of my engine does not produce temperatures/loads required for regeneration?

Some emergency electrical generator engines operating at low loads (i.e., without an electrical load on the generator) may not generate sufficient engine exhaust temperatures to sustain filter regeneration for passive DPFs during routine maintenance and testing operations. Below are alternatives that can be used to remedy this issue.

Load Bank

Load banks are used to simulate an electrical load, thereby increasing the load on the engine and increasing the exhaust temperature for filter regeneration. Load banks operate on the principle of electrical resistance and create a load on an electrical generator by removing and converting energy from the generator into heat, which is then dissipated from the load bank (usually by air).

Building Load

In lieu of load bank use, emergency generator engine operators may place an electrical load on the generator by utilizing the generator for its designed purpose (e.g., switch to building electrical load).